# Methods

*Health of Boston 2016-2017* presents a wealth of data related to the health experience of Boston residents. These data provide information that describes the population, social and environmental factors that impact health (i.e. social determinants), individual health-related behaviors and risk factors, access to health care, health events including births, hospital patient encounters, and deaths, and the prevalence of common health conditions. Data were analyzed and are presented in a manner seeking to maximize their contribution towards furthering our understanding of the Boston resident health experience. Most survey and non-survey data for this report were analyzed using SAS version 9.4 statistical software. Analytical methods applied to these data often reflect adaptation of the Centers for Disease Control and Prevention National Center for Health Statistics (CDC-NCHS) methods and standards to the analysis of small population (i.e., not national or state-level) health data.

## Methods for Survey Data

### *Sources*

Adult chronic disease, health risk, and screening data from the Boston Behavioral Risk Factor Surveillance System (BBRFSS), youth health risk data from the Youth Risk Behavior Surveillance System (YRBSS), and demographic data from the American Community Survey (ACS) result from sample surveys administered approximately every other year as specified for BBRFSS and YRBS and every year for ACS. The resulting data were adjusted (i.e., weighted) to represent the entire Boston population of adults living in households (BBRFSS), the entire Boston public high school student population (YRBSS), or the entire Boston population or appropriate sub-population groups (ACS).

### *Sampling Error*

All survey data in this report present with **associated sampling error** resulting from the likely difference between the given known sample of survey respondents (i.e., residents who complete the survey) and the unknown actual population that the sample is meant to represent. Sampling error acknowledges that the resulting survey percentages coming from a collection or sample of residents (i.e., survey respondents) are estimates that likely differ from survey to survey and from the unknown measurements of the entire population. When survey respondents are selected randomly from the population, statistical methods may be applied to estimate the amount of sampling error associated with each survey result (e.g., percentage or point estimate for a population group). There are different types of expressions of the amount of error associated with a given result (e.g., "margin of error", "standard error", "relative standard error") but all are meant to give a sense of how accurate the result is considered as a measurement for the entire population. The precision or accuracy of the survey results generally improves and the sampling error decreases as the number of survey respondents (or sample size) increases. In order to gain a sense of the degree of accuracy (or how much sampling error exists for a given percentage or point estimate), 95% confidence intervals were generated to present along with the survey-based percentages or point estimates for the population.

**Confidence intervals present a range of values above and below the point estimate that possess a high likelihood of containing the actual or true population percentage or rate.** In this manner, confidence intervals are an expression of the sampling error. Smaller confidence intervals signify less sampling error and greater data precision than larger confidence intervals. **In the report graphs of survey data, 95% confidence intervals are shown using error bars above and below the rate or percentage point.** Though not presented, the relative standard error or RSE (i.e., ratio of the point estimate standard error to the point estimate) was calculated and used to further assess survey data precision. Consistent with CDC-NCHS methods, survey results were not presented if the RSE equaled or exceeded 30%.

*Comparing Confidence Intervals*

As noted above, error bars are used to show the 95% confidence intervals of survey data results within graphs in the report. As a result, rates or percentages for two groups within a graph may be compared by visually assessing whether or not their respective confidence intervals overlap. If the intervals do not overlap, the difference between the two is considered statistically significant and one group's rate or percentage is considered higher or low than the other group's rate. This method can be used to compare percentages that weren't tested as part of the routine statistical testing performed for the report (e.g., for two non-white racial/ethnic groups or for two specific years within a series of years). Comparison of confidence intervals is considered a conservative proxy for statistical testing because while these comparisons will reveal significant differences when the confidence intervals do not overlap, they do not reveal all significant differences. There are instances when comparisons of slightly overlapping confidence intervals would yield significant results if they are tested using statistical procedures.

*Assessing Differences between Two Population Groups*

Rate differences between two demographic groups were assessed using statistical procedures. Statistical procedures account for the sampling variation in making comparisons. For these analyses differences between demographic groups accounting for sample variation were assessed using Wald chi-square tests with logistic regression (BBRFSS, YRBSS, and ACS-PUMS survey data), as well as Z-tests (non-PUMS ACS survey data). All statistically significant population group differences are noted in the graphs and specified as either "higher than" or "lower than" the reference group rate within the interpretative text below the relevant graphs.

*Trend Analysis*

For BBRFSS and YRBS survey data, logistic regression with associated testing was used to assess linear odds change (increased or decreased) over time. Of note: logistic regression used complex survey procedures to accommodate BBRFSS and YRBS complex survey designs.

All statistically significant changes over time for a given population group are noted in the graphs and specified as either having "increased" or "decreased" within the interpretative text below the relevant graphs.

## Methods for Non-Survey Data

*Sources*

Health event data (e.g. births, deaths, hospital patient encounters, treatment encounters) for an entire population within a specified time period are considered non-survey data. Usually presented as population-based rates (e.g., deaths per 100,000 residents), non-survey data are not considered estimates but true expressions of the entire population experience.

*Random Variation*

Though non-survey data (e.g., births, deaths, hospital patient encounters) do not possess sampling error, they could be thought of as one draw of an infinite number of presentations of those data in time. In this sense, non-survey data are viewed as **possessing varying degrees of random variation**. Random variation acknowledges that repeated measurements of the same natural phenomena (e.g., infant deaths in any number of unspecified years) will likely give slightly different results and, thus, there exists a degree of randomness associated with each individual year's result (e.g., number of infant deaths in a specific year). Non-survey data rates based on small counts or rare events are considered more susceptible to consequential effects of random variation and are considered less stable as a result. **Within the report graphs, notation was used to indicate rates derived from non-survey data that were based on 20 or fewer events (e.g., patient encounters, deaths) indicating that these rates are considered unstable and should be interpreted with caution.**

*Assessing Differences between Two Population Groups*

Rate differences between two demographic groups were assessed using statistical procedures, specifically using Wald chi-square tests with Poisson regression.

**Demographic group differences were typically based on a comparison of single-year rates for the most recent data year, usually 2015, or combined years if necessary to obtain sufficient numbers of cases necessary for comparisions of rates with adequate precision. As a rule, racial/ethnic group comparisons involved using White residents as the reference group** and assessing the difference between each non-White resident group rate (e.g. rate for Black residents) and the White resident (reference group) rate. For sex-based comparisons, males are the reference group. **Neighborhood comparisons involved assessing the difference between a given neighborhood's rate and the rate for the rest of Boston** (those residents not living in the specified neighborhood). These comparisons are considered more accurate than comparisons to Boston overall. The actual 'rest of Boston' rates are not presented in the report as they are of limited practical value.

*Trend Analysis*

Whether rates of non-survey data increased, decreased, or did not change across the five-year time period was determined using Poisson regression, a statistical process that considers the rate at all time points when determining the magnitude and direction (i.e., increasing, decreasing, or neither increasing nor decreasing) of linear change over time. **Note: Poisson regression produces percent change over time results that most often are not equal to those obtained by calculating the simple percent difference between the first and last time point.** Percent change over time was indicated within the interpretative text if the associated tests (Wald chi-square) were statistically significant ($p<.05$).

### *Age-Adjusted Rates*

Within this report most health event rates of non-survey data, including all mortality and hospital patient encounter rates, are age-adjusted (as opposed to unadjusted or crude) to permit comparisons that mitigate the impact of differences in age distributions of their respective underlying populations. The resulting comparisons, then, allow consideration of observed differences in terms of factors other than population age differences. Mortality age-adjusted rates were scaled per 100,000 residents. Hospital patient encounter rates were typically scaled per 10,000 residents.

### *Boston Population Estimates*

Boston population data used as denominators in the rate calculations was produced by the Boston Public Health Commission Research and Evaluation Office Boston Population Estimates Project (B-PEP). B-PEP uses 2000 and 2010 United States Census data for Boston to generate population estimates for each year between the 2000 and 2010 and for years after 2010. B-PEP apportions the age, race/ethnicity, sex, and neighborhood population change incrementally across all data years. As needed, B-PEP sums age, race/ethnicity, sex, and neighborhood population totals required for rate denominators that then account for underlying population change within specified time periods and over time. Of note, B-PEP estimates used for health data rates are different than population estimates derived from the American Community Survey (ACS) that are presented in Chapter 1: Demographics of the report.

### *Validity*

Data representing populations have a number of limitations. In general, validity, or how accurately the data present the actual population experience, depends on how well the information is collected and how much population data (i.e., the number of cases, records, health events) are collected. Once a relevant data source is determined to be of high quality and the decision to analyze the data has been made, analytical methods and rules are applied to determine if and how to present the data. These rules are meant to safeguard against both inadvertently identifying individuals whose health data is being analyzed and against misrepresenting the population experience. Similar rules apply to both survey and non-survey data.

*Data Suppression*

In order to maintain confidentiality of the individuals whose data was being assessed and to promote overall reasonable levels of precision for population parameters, a number of data suppression rules were applied specific to relevant data sets:

- No birth or mortality rates were generated for population groups with fewer than five events for a given year or time period.

- No hospital patient encounter rates (including rates of hospitalizations and emergency department visits) were generated for populations groups with fewer than 11 cases.

- No survey percentages or point estimates from the BBRFSS or YRBSS surveys were generated if sample sizes were fewer than 50 or 100 respondents, respectively, or when fewer than five respondents indicated one of the response choices.

- Survey percentages or point estimates greater than 5% were not presented if the relative standard error equaled or exceeded 30% (see Sampling Error under Methods for Survey Data).

*Combining Data Across Multiple Years*

Combining data across multiple years in order to increase the number of cases is a commonly practiced epidemiological method for generating rates that are considered more stable (i.e. less vunerable to the effect of random variation) than individual year rates when the number of cases or deaths is small. This is, also, a useful method for achieving the minimum count thresholds required by the data suppression rules described above. For this report, with very little exception, **data were combined across as many of five data years as necessary in order to maximize the number of population group rates presented** (e.g., to permit the computation of Asian resident rates or percentages for at least 10 neighborhoods). Resulting rates and comparisons, then, speak for the average annual experience during the combined years and likely mask specific differences for subsets of the combined or individual years.

*Assessing Rate Change Over Time (i.e., Trends)*

Many graphs of health indicators in the report show rates or percentages for the most recent five data years, typically from 2011 to 2015 for non-survey data and 2006-2015 or 2007-2015 for the biennial survey data. For non-survey and survey data, rate change over time for a given population group was assessed using statistical procedures. For this reason, one's visual interpretation of the data in the report charts (i.e., whether increasing or decreasing) may not reflect what is expressed by the chart notation and or in interpretative text.

For additional information regarding the analytical methods used within this report, please contact the Boston Public Health Commission Research and Evaluation Office.